GEOPROCESS FILE
SUMMARY REPORT

DAWSON MAP AREA
N.T.S. 116B and 116C (E1/2)

INTRODUCTION

The GEOPROCESS FILE is a compilation of information and knowledge on geological processes and terrain hazards, including mass movement processes, permafrost, flooding risks, faults, seismic activity and recent volcanism, etc. Please refer to the GEOPROCESS FILE Introduction and Users Guide for more in-depth information on how the maps were developed, which other GEOPROCESS FILE maps are available, how to utilize this inventory and how to interpret the legend. Special interest should be taken in the detailed description of the terrain hazard map units. Appendices in the Users guide include summary papers on the geological framework, permafrost distribution, and Quaternary geology in Yukon and a list of comprehensive GEOPROCESS FILE references.

This report includes a brief discussion of the scope and limitations of the GEOPROCESS FILE compilation maps and summaries followed by summaries of the bedrock geology, surficial geology and terrain hazards for this N.T.S. map area, and a list of references.

Geological Processes and Terrain Hazard Compilation Maps

The GEOPROCESS FILE map units were drafted on the 1:250,000 topographic base maps through interpretation from bedrock geology maps, surficial geology maps and in some cases terrain hazard maps at various scales. The compilation maps have a confidence level reflecting the original source material. All materials used to produce the maps are listed in the references attached to each map. A file containing the documentation used to construct these maps is available at Exploration and Geological Services Division, Indian and Northern Affairs Canada in Whitehorse, Yukon. Areas for which no surficial geology or terrain hazard information is published were left blank. Summary reports on surficial geology and terrain hazards for these map sheets were written by extrapolating the data from adjacent map sheets or smaller scale maps. Information from small scale (e.g. 1:1,000,000) maps was used for the summary reports, but not redrafted onto the 1:250,000 GEOPROCESS FILE maps.

The GEOPROCESS FILE compilation maps are intended as a first cut planning tool; the legend on the maps describes the general aspects of terrain hazards (also see below) and associated geological processes. **These maps should never replace individual site investigations for planning of site specific features, such as buildings, roads, pits, etc.**

Bedrock Geology Summaries

Each 1:250,000 N.T.S. map area is described according to morphogeological belts and terranes defined by Gabrielse *et al.* (1991) and Wheeler *et al.* (1991). Bedrock geology, geological structures and mineral occurrences are briefly described and taken largely from the referenced, most recent 1:250,000 geological map with additional contributions from Wheeler and McFeely (1991), and Yukon MINFILE (1993). A summary paper ("A Geological Framework for Yukon") in Appendix A provides a framework and context for each of the bedrock summaries.

The level of knowledge and understanding of Yukon geology is constantly evolving with more detailed mapping and development of geological models. Names, ages and terrane affinities of rock units on the most recent 1:250,000 geological maps may, in some cases, now be considered incorrect. Thus information contained within some of the bedrock geology summaries may be out of date. Although much of the information reflects the knowledge at the time that the source map was published, additional information has been inserted whenever possible to assist the user in merging the information with current geological maps, concepts and understanding. The age ranges for similar packages of rocks may also vary between map areas since the actual rocks, or at least the constraints on their age, may vary between map areas.

BEDROCK GEOLOGY (Green and Roddick 1961)

The Dawson map area is mainly within the Omineca Belt Plateau except for the northern one-third which is in the Foreland Belt. The major physiographic feature in this map area is the Tintina Trench which forms a northwest-trending valley across the map area and broadens to more than 20 kilometres in width in the south. Northeast of the Trench the topography is mountainous and rugged (the Ogilvie Mountains). Southwest of the Tintina Trench the topography is subdued and characterized by low rounded, dome-style mountains and hills. The variable physiography on each side of the Tintina Trench is a reflection of the bedrock geology and glaciation.

The bedrock geology southwest of the Trench is dominated by four packages of Yukon-Tanana Terrane metamorphic rocks: pre-570 to 320 million years Nasina (and Nisling) Assemblage micaceous quartzite, quartz-mica schist, quartz-biotite gneiss, graphitic schist and quartz-muscovite-chlorite schist; 350 million year old quartz-biotite gneiss; 290-245 million year old quartz-muscovite-chlorite schist and chloritic quartzite known as the Klondike schist; Slide Mountain Terrane greenstone, amphibolite and serpentinized ultramafic rocks.

Northeast of the Tintina Trench are four packages of variably deformed and metamorphosed sedimentary rocks. These include a pre-800 million year old package of Fifteenmile Group, Windemere Group and Wernecke Supergroup vari-coloured, thin-bedded argillite, slate, phyllite, quartzite, dolomite, conglomerate, limestone and siltstone; 800 to 530 million year old Hyland Group gritty quartzite, sandstone, quartz pebble conglomerate, black, maroon and green shales and slates, schistose quartzite quartz-chlorite schist, quartz-mica schist, phyllite, limestone, chert, dark green volcanic flows, breccia, tuff and agglomerate; 530-200 million year old Selwyn Basin stratigraphy that includes Road River Group black chert, black argillite, quartzite, dolomite, limestone and partly serpentinized volcanic rocks, Earn Group black argillite, shale, slate, limestone, quartzite and chert pebble conglomerate, and Tahkandit Formation chert, and cherty limestone; and graphitic quartzite, slate and phyllite of the 360-320 million year old Keno Hill Quartzite. Dykes and sills of 220 million year old gabbro and diorite intrude the Keno Hill Quartzite.

The northeast portion of the area is structurally complex and dominated by intense folding and large thrust faults including the Dawson, Tombstone and Robert Service Thrust Faults. Wernecke Supergroup rocks contain numerous large areas dominated by breccias (Wernecke breccia). Tombstone Suite plutons composed of 90 million year old hornblende-biotite syenite and granite are found in the Tombstone Mountain area. Close to and southwest of the Tintina Trench are several 50 million year old granodiorite and quartz monzonite plutons. Within the Tintina Trench, northwest of Dawson, 50 million year old coal-bearing arkose, sandstone and conglomerate are associated with minor basalt flows.

Mineral deposits and occurrences

The Dawson map area hosts a large and varied array of mineralization. Yukon MINFILE lists 168 occurrences. Numerous gold-bearing veins occur in the Dawson City and Tombstone Mountain areas. Lead-zinc-silver veins are common in the sandstone and carbonate rocks of Mackenzie Platform. Copper, gold, uranium, fluorine, tungsten, molybdenum, antimony mineralization is spatially related to the Tombstone suite plutons. The Brewery Creek bulk mineable gold deposit is an oxidized intrusive associated vein deposit containing 17 million tonnes of 1.4 g/t Au. The Marn skarn deposit contains approximately 300,000 tonnes of 8.6 g/t Au, 1% Cu, .1% W and 17 g/t Ag. Numerous asbestos occurrences are known and are genetically associated with Slide Mountain Terrane ultramafic bodies. The largest asbestos deposit was the Clinton Creek mine which produced 940,095 tonnes of asbestos from 16 million tonnes of ore. More than 15 coal occurrences, some past producers, are associated with sedimentary rocks in the Tintina Trench. The Blende deposit contains 19.5 million tonnes of 3.0% zinc, 2.8% lead and 56 grams per tonne silver. Other mineral showings in the Dawson area include copper skarns and veins, and sedex barite and zinc. Although the Dawson area is famous for its placer gold production, most of the Klondike goldfields are in the Stewart River map area and not the Dawson map area.

SURFICIAL GEOLOGY

Most of the Dawson map area is believed to be located in the unglaciated portion of the Western Yukon Plateau. Recent work by Duk-Rodkin in that area may provide a better history of the early glaciations in that area (Duk-Rodkin, in prep.). The following history is based on information available at the time of compilation.

During late Tertiary time (2 million years ago), smooth rounded summits and valleys formed as a mature landscape with a well developed system of streams which drained in a southerly direction. After a period of tectonic stability (e.g. inactive faults), uplift occurred (e.g. upward movement in the crust) which continued into the Quaternary time period, 2 million years to present, (Templeman-Kluit, 1980). Drainage systems became entrenched and with the onset of Quaternary glaciations, drainage reversals in a northerly direction occurred throughout central Yukon (Templeman-Kluit, 1980). For example, prior to glaciations the Klondike River flowed southeast to Steward River with a drainage divide just east of the mouth of Hunker Creek (Thomas and Rampton, 1982b). The earliest glaciation in the area reached the Tintina trench and the flow of the Klondike River was reversed.

The White Channel Gravel, well known in the Dawson area, are the tall white gravel exposures seen along the Klondike Highway and along Hunker and Bonanza Creeks. These gravel were deposited by a multi-channelled stream system (Morison, 1985) during the Pliocene and continued during uplift of the area. Deposition of the White Channel Gravel is believed to have ended with the onset of pre-Reid glaciations in early Pleistocene (2 millions years ago). The elevated position of these gravel beds is the result of post depositional uplift and incision to present creek level

The extent and age of these early (pre-Reid) glaciations are not known. Isolated patches of till outcrop within the pediment deposits beyond the Reid glacial limits and erratic boulders have been found 100m. higher than the Reid moraines, indicating previous glacial activity. Downcutting of the streams took place before and during the Reid glaciation, resulting in a series of terraces and gravelly deposits.

Reid glaciation is marked by major valley glaciers flowing from cirques in the Southern Ogilvie Ranges (Thomas and Rampton, 1982a). The glaciers flowed down tributary valleys and in some cases joined together. Outwash deposits associated with the retreat of Reid glaciers are now present in the Klondike valley on the higher terraces.

McConnell glaciation was less extensive and not all cirques occupied by glaciers during the Reid glaciation were active at this time (Thomas and Rampton, 1982a). Glaciofluvial terraces resulting from this ice retreat are preserved as low terraces inset into the higher Reid terraces.

Some of the richest fossil sites of Pleistocene mammals are found in the Klondike area. Findings include steppe bison, small horse, woolly mammoth, Dall sheep and caribou, various members of the rodent family, short faced bear, American lion and several others. The animals are believed to have occupied steppe-like grassland (Beringia) during the last glaciation (Harrington, in Morison and Smith, ed. 1987).

TERRAIN HAZARDS

The main source of information for the terrain hazards map is derived from surficial geology and geomorphology maps of Thomas and Rampton (1982a and b) and is limited to the east half of map 116B. The Geological Survey of Canada Pacific Geoscience Center in Victoria provided the seismic information.

Seismicity

There are 68 recorded seismic events within the Dawson map area. Most of the events are on the northeast side of the Tintina Fault. The Tombstone Mountain area is host to a concentration of events; including two of magnitude 5.0-6.0 (the highest recorded readings in the map area) and eleven of magnitude 4.0 to 5.0

Mass Movement Processes

Permafrost is present on north facing slopes, and processes such as solifluction, soil creep, nivation and cryoturbation can occur. Slow mass movement as creep, solifluction lobes and stripes are common on colluvial covered slopes. Active layer detachment slides and retrogressive thaw flow slides are common in the moraines. Fine-grained sediments in the valley bottoms are underlain by permafrost with high ice content, which may thermokarst if disturbed. This risk is less severe if the fine grained deposits are underlain by gravel, as is the case on mid-to high elevation terraces of the Klondike river (Mougeot, 1994). Avalanches and rockfalls are always a possible risk on steep slopes, and bedrock such as the Klondike schist and ultramafic rock may fail if slope conditions such as degrading permafrost or excessive moisture are present. An example of a mass movement failure is the large landslide above the townsite of Dawson which is chiefly composed of friable ultramafic bedrock.

Permafrost

The Dawson map sheet lies within the widespread discontinuous permafrost zone (Brown, 1968). Permafrost is very common in thick organic-rich silt deposits. Large bodies of segregated ice, ice wedges and ice layers are visible in many of the placer mine pit walls excavated in such sediments (French and Pollard, 1986; Mougeot, 1994). In some cases the solid ice bodies from 15 to 100 m thick. In general, most fine textured sediments in poorly drained areas with peat, thick moss and/or organic soils, will be underlain by permafrost. The uppermost metres of bedrock may be included when is it composed of altered, friable schist. The active layer is at its thickest by mid- to end- August. Erosion of the surface or slopes of these sediments, either by creek, river, forest fire or human activities can result in either mudslide, detachment slides, thermokarst subsidence, deterioration of the drainage for several years. Solifluction lobes are widespread throughout the area on colluviated slopes. Rock glaciers are common at high elevation on north and northeast facing slopes.

Flooding and Other Risks

High water levels have been experienced as a result of floating ice jams on the Yukon River downstream of Dawson City and on the Klondike River at/near the mouth as well as from open water flows from the Yukon River (McLellan, 1983). Dawson City has known several severe floods during its history which were caused mainly by ice jams and open water flow. High water levels have been frequent enough (at least 6 times since 1925) to justify the construction of a dyke along the Yukon River in Dawson City. The community of Rock Creek as well as several locations along the Klondike highway have also been subjected to floods induced by ice jams.

In smaller drainage basins in that area unusually high water levels can be caused by snow melt run-off, rainstorm events, or a combination of both, and ice jams during the spring break-up period. The effect of snow melt and heavy rain are greater on smaller basins.

References

Dawson Map Area
N.T.S. 116B and 116C (E1/2)

Note: **To be thorough, check the references for adjacent N.T.S. map sheets and the General Reference List.**

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